INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TESTS DIVISION

HIGH PRESSURE AIR CONTENT OF HARDENED PORTLAND CEMENT CONCRETE
ITM No. 401-00T

1. SCOPE

1.1 This test method covers laboratory determination of the air content of hardened Portland cement concrete with the use of the High Pressure Air Meter. This determination is made from the observation of change in linear piston movement with a specimen in the test chamber, from that of the linear piston movement with no specimen in the test chamber. This change is due to a specific volume of compressible entrained air being replaced with a specific volume of incompressible water. This test method also covers the determination of the plastic air content of concrete tested using the high pressure method based on a statistical relationship between hardened and plastic air content.

1.2 The values stated in either SI metric or acceptable English units are to be regarded separately as standard, as appropriate for a specification with which this ITM is used. Within the text, English units are shown in parenthesis. The values stated in each system may not be exact equivalents; therefore each system shall be used independently of the other, without combining values in any way.

1.3 This ITM may involve hazardous materials, operations, and equipment. This ITM does not purport to address all of the safety problems associated with the ITMs use. The ITM user's responsibility is to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2.0 REFERENCED DOCUMENTS

2.1 AASHTO Standards

T 152 Air Content of Freshly Mixed Concrete by the Pressure Method.

3.0 TERMINOLOGY

3.1 Terms and Abbreviations. Definitions for terms and abbreviations shall be in accordance with the Department’s Standard Specifications, Section 101, except as follows.

3.1 Terms and Abbreviations

3.1.1 Linear Piston Movement, LPM. The linear piston movement is the travel of the hydraulic piston with a specimen in the test chamber.

3.1.2 Initial Value, INIT. The initial value is the stabilized travel of the hydraulic piston with no specimen in the test chamber.

4. SIGNIFICANCE AND USE

4.1 This test method covers determination of the air content of hardened concrete exclusive of any air that may be inside voids within aggregate particles. Therefore, determination of an aggregate correction factor, in accordance with the applicable requirements of AASHTO T 152, is required.

5. APPARATUS

5.1 High Pressure Air Meter

5.1.1 Hydraulic Pump and Hydraulic Cylinder. A specially designed unit combining a hydraulic pump and a hydraulic cylinder employed to supply the 34 470 kPa (5000 psi) load required to force water into a concrete specimen in the test chamber. The unit is supplied air pressure, which is converted to water pressure by movement of the hydraulic piston.

5.1.2 Test Chamber. A specially designed stainless steel seamless tube secured with a stainless steel plate, at the bottom, and a stainless steel lid, at the top. This chamber is designed to contain water under pressure.

5.1.3 The System. The hydraulic cylinder, of known volume, is attached to the test chamber, of known volume, that is completely filled with deionized water. This is done in order to enable load from the hydraulic pump to be applied to the test chamber. The system is equipped with a dial gage accurate to 0.0254 mm (0.001 in) in order to measure the movement of the hydraulic piston. Volume displacement is determined by the measured movement of the hydraulic piston.

6. SAMPLING

6.1 Obtain a sound concrete sample free of steel reinforcement. The sample must be of suitable size to fit into the test chamber. The diameter of the stainless steel lid is 173 mm (6.8 in.) and the depth of the seamless tube is 480 mm (16.9 in.).

7. PREPARATION OF THE TEST SPECIMEN

7.1 Oven Drying. In order to ensure uniformity of each concrete sample the specimen is oven dried for 72 hours at 138-149 °C (280-300 °F).

7.2 Saturation. Air voids in concrete capable of absorbing water easily, entrapped air, cannot be considered entrained air. The air content determination must be made on concrete in the fully saturated condition. For this reason, after the specimens are oven dried, they must be saturated in 22 ± 1 °C (72 ± 2 °F) water for a period of 40-48 hours.

7.3 Unit Mass (Weight). Determine the unit mass (weight) of the concrete sample in accordance with T 121.

8. PREPARATION OF TEST EQUIPMENT

8.1 Preconditioning the Water.

8.1.1 Prior to opening the test chamber, close all valves except the valve positioned between the test chamber and the hydraulic cylinder. Remove the lid of the test chamber by loosening the wing nut, at the top, thereby releasing the steel cross bar used to secure the lid. Tilt the lid and remove from the chamber by aligning the flat sides of the lid with the flat sides of the test chamber.

8.1.2 Completely fill the test chamber with deionized water. Remove the pressure gage and replace it with a plug capable of withstanding a 206 kPa (30 psi) vacuum. Apply teflon tape to the plug, prior to installation. Place the vacuum lid over the top of the test chamber. It may be necessary to apply vacuum grease to the O ring of the vacuum lid to prevent leakage.

8.1.3 Engage the vacuum by turning on the power and opening the valves connecting the vacuum lid to the vacuum hose and the vacuum hose to the vacuum. The pressure gage should read at least 170 kPa (25 psi). Apply the vacuum until air bubbles being pulled to the surface are no longer visible, this may be done overnight. The vacuum is applied to remove as much air as possible prior to the determination of the initial value.

8.1.4 Disengage the vacuum by closing the valves previously opened and turning off the power. The gage should return to zero. Apply teflon tape to the pressure

gage and replace the plug with the pressure gage. Replace the vacuum lid with the test chamber lid, do not secure lid.

8.2. Bleeding the System. The system is bled to remove all entrapped air bubbles that may have developed throughout the workings of the high pressure air meter. This is done by forcing water through the system.

8.2.1 Close the valve positioned between the test chamber and the hydraulic cylinder. Open the drainage valve positioned at the bottom of the test chamber. Allow water to freely flow from the drainage hose to ensure no entrapped air. Close drainage valve, and secure chamber lid by placing cross bar over the top of the lid and tightening the wing nut.

8.2.2 Open the valve connected to the graduated cylinder located at the top of the test chamber. Fill the graduated cylinder with water. Open the valve opposite this valve and allow gravity to force water through the test chamber. Do not allow water to splatter onto the high pressure air meter. Continue until no air bubbles are visible and the height of the water in the graduated cylinder reads 50 ml or below. Do not allow the water to completely drain, if this does occur go back to 8.2.1 and repeat. Close valve opposite valve attached to graduated cylinder.

8.2.3 Open valve positioned between the test chamber and the hydraulic cylinder. Use the hydraulic pump, in the load position, to force water through the system. Water will be forced into the graduated cylinder, continue in the load position until the graduated cylinder is filled. Reverse hydraulic pump to release position and drain the graduated cylinder. Continue process until no air bubbles appear in the graduated cylinder. Close valve attached to the graduated cylinder. The valve positioned between the test chamber and the hydraulic cylinder must remain open.

9. PROCEDURE

9.1 Determination of the Initial Value

9.1.1 Place the hydraulic pump in the load position. Apply the load until the pressure in the test chamber is exactly 34 470 kPa (5000 psi). Record the value read from the dial indicator attached to the hydraulic ram on Appendix A. Release the load very slowly, if the load is released to quickly the well holding the hydraulic fluid will overflow. Bleed the system as identified in 8.2, beginning at 8.2.2.

9.1.2 Repeat this process until the difference in subsequent LPM is 0.0762 mm (0.003 in) or less. This value is considered the INIT, record all readings on form A, Appendix A

9.2 Testing Hardened Concrete Specimen

9.2.1 Remove the lid of the test chamber. Open the drainage valve to release volume of water approximately equal to volume of the test specimen. Place test specimen in test chamber using forceps, it is crucial that the water in the test chamber is disturbed as little as possible. This is to prevent introduction of air into water within the test chamber. Bleed the system as identified in 8.2 beginning at 8.2.2 Place the lid on the test chamber and secure.

9.2.2 Check all valves, except valve positioned between the test chamber and the hydraulic cylinder, to make certain that they are tightly closed. The valve positioned between the test chamber and the hydraulic cylinder must remain open. Apply load until pressure in the test chamber is exactly 34 470 kPa (5000 psi).

9.2.3 Immediately record the value read from the dial indicator identifying the LPM. Record the time of the reading and hold the 34 470 kPa (5000 psi) load. The LPM measured via the dial indicator must be recorded at 5 minute intervals. This value should only be read when the pressure in the test chamber is at 34 470 kPa (5000 psi).

9.2.4 It will be necessary to reapply the pressure lost due to the compression of air, in the test specimen, within the first 5 minutes of testing. It may be necessary to reapply pressure at subsequent 5 minute time intervals, to maintain the

34 470 kPa (5000 psi) load. Maintain the 34 470 kPa (5000 psi) load until the movement of the piston remains the same for 15 minutes. Record this stabilized LPM on form B, Appendix B.

9.2.5 Record the INIT value obtained in 9.1 on form B, Appendix B.

10. COMPLETION OF THE TEST PROCEDURE

10.1 Open the lid of the test chamber and remove the specimen from the test chamber.

10.1.1 If testing is complete replace water removed from the test chamber and close the lid of the test chamber.

10.1.2 If additional testing is required repeat process beginning with 8.2.

11. CALCULATION

11.1 Calculate the volume of the test specimen as follows:

Metric

Volume = [_____kg / _____ kg/m^3 * $(1000\ mm/m)^3$
SSD UNIT MASS (WT)

Volume = _____ mm^3

English

Volume = [_____kg / 0.4535924 kg/lbs. * $(12\ in/ft)^3$] / _____ pcf
SSD UNIT MASS (WT)

Volume = _____ in^3

11.2 Calculate the hardened air content of the test specimen

Metric

Hardened Air Content = {[462121.65 * (___ - ____)] / _____} + 1.46 - _____
LPM INIT Volume Agg. Correction

Hardened Air Content = _____%

English

Hardened Air Content = {[716.29 * (___ - ____)] / _____} + 1.46 - _____
LPM INIT Volume Agg. Correction

Hardened Air Content =_____%

11.3 Calculate the plastic air content of the test specimen

Plastic Air Content = (Hardened Air Content - 1.53) / 0.9

Plastic Air Content =_____%

12. REPORT

12.1 Record the hardened concrete air content.

12.2 Record the plastic concrete air content.

APPENDIX A

High Pressure Air Content of Hardened Portland Cement Concrete
ITM 401A
INITIAL VALUE DETERMINATION

OPERATOR_____
RECORDER_____
DATE _____

LPM	TIME	COMMENTS

INITIAL VALUE:_____

Transfer to Appendix B

APPENDIX B
High Pressure Air Content of Hardened Portland Cement Concrete
ITM 401B
AIR CONTENT DETERMINATION

OPERATOR_____
RECORDER_____
DATE _____
LAB # _____

INIT:_____

LPM	TIME	COMMENTS
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

CALCULATION
Metric
Volume = [_____kg / _____ kg/m^3 * $(1000\ mm/m)^3$
SSD UNIT MASS (WT)

Volume = _____mm^3

English
Volume = [_____kg / 0.4535924 kg/lbs * $(12\ in/ft)^3$] / _____ pcf
SSD UNIT MASS (WT)

Volume = _____ in^3

Hardened Air Content
Metric
Hardened Air Content = {[462121.65 * (___ - ____)] / _____} + 1.46 - _____
LPM INIT Volume Agg. Correction

Hardened Air Content = _____%

English
Hardened Air Content = {[716.29 * (___ - ____)] / _____} + 1.46 - _____
LPM INIT Volume Agg. Correction

Hardened Air Content =_____%

Plastic Air Content
Plastic Air Content = (Hardened Air Content - 1.53) / 0.9

Plastic Air Content =_____%